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WATER SUPPLY PROBLEMS

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WATER SUPPLY PROBLEMS

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Much has been written regarding Delaware Valley, U.S.A. Almost daily the Philadelphia newspapers refer to the development in this Valley. We hear this development called the "industrial renaissance". It is referred to as a new birth or a revival. Some people say it is a transitorial movement such as occurred in Europe from the medieval to the modern. Special supplements have been published to our newspapers which dwell upon its great features. Many fine things have been said about the available port facilities; and consideration is being given to the regional planning of the territory. But very little has been said about one important factor in this development, and that is Water Supply. Except for the controversy which exists in connection with the diversion of water from the upper Delaware River by New York City, we hear nothing on the relation of Water Supply to this renaissance.

On the other hand, during the past decade, consideration has been given to a comprehensive project for the utilization of the waters of the Delaware River; but at this moment a definite plan of procedure has not been adopted.

The physical changes in the Delaware Valley are obvious. You cannot drive many miles in any part of the region without seeing at least one major project under construction. This development extends from Trenton on the north to Wilmington on the south. The term Delaware Valley, U.S.A., as used in the public press, includes 11 counties, five of which are in Pennsylvania, five in New Jersey and one in Delaware. This region is also called "The Greater Philadelphia Area" and it embraces Bucks, Chester, Delaware, Montgomery and Philadelphia Counties in Pennsylvania; Burlington, Camden, Glouster, Mercer and Salem Counties in New Jersey and New Castle County in Delaware.

The President of the Chamber of Commerce of Greater Philadelphia has stated—and the same thing has also been said by many other people and groups—that this region is the fastest growing industrial and manufacturing area in the United States. These industries are unusually highly diversified, with 8100 manufacturing concerns and almost 53,000 wholesale, retail and service establishments. The President of the Chamber of Commerce has also stated that the post-war expenditures in capital improvements in the region exceed 5 billion dollars, and this estimate, mind you, only includes outlays on over 5 million dollar projects. He furthermore points out that the population growth of the Metropolitan Philadelphia Area is the highest in the United States percentage-wise. Its 1950 population was over 4 million. The estimated 1960 population is over 5 million, and the Chamber of Commerce of Greater Philadelphia goes so far to predict that the population in the year 2000 is expected to reach almost 10 million persons in the Delaware Valley, U.S.A. More conservative estimates place this population in the year 2000 at somewhat over 6 million persons.

The estimates of the Chamber of Commerce may be typical of that type of agency and somewhat exaggerated, but they nevertheless portray the thinking of the industrialists in this area; and while these estimated populations may never be reached, these predictions should nevertheless be considered as the judgement of a group of people represented by the Chamber of Commerce who

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will be responsible for developing the Delaware Valley, U.S.A. In view of this contemplated increase in population, it is essential that the waters of the Delaware River and its tributaries, and also the ground waters of the region, be conserved and developed in accordance with a comprehensive plan and not in a piecemeal fashion.

The health of the people in a community should stand foremost in rank of all municipal and urban considerations, for upon their health depends the happiness and the prosperity of the region. We could get along today without many of our up-to-date improvements although it might inconvenience us. On the other hand, it would be impossible for us to live in a modern up-to-date fashion in an urban area without first a public water supply and, second, facilities for the collection and disposal of sewage. I, therefore, believe it is of paramount importance that those who are responsible for the development of the Delaware Valley, U.S.A. should give prompt and careful attention to the water supply problems which now exist and which are bound to become more acute as time goes on.

The Delaware River Watershed

The Delaware River Watershed comprises an area of 10,444 square miles of which 6,076 square miles are in Pennsylvania, 2,389 square miles in New York State and 1,979 square miles in New Jersey. The watershed area draining to Trenton, New Jersey, totals 6,780 square miles. That part of the Delaware Valley, U.S.A. in both Pennsylvania and New Jersey is dependent upon the Delaware River and its tributaries for public and industrial water supplies with the exception of some industries and municipalities which utilize ground water supplies.

Use of Delaware River in Pennsylvania and New Jersey for Water Supply Purposes

It is obvious that the Delaware River will become less desirable for water supply purposes as the population and industrial growth increases in the Delaware Valley, U.S.A., with the consequent pollution of the waters.

The 1952 water use from the Delaware River and from wells along the river in the State of New Jersey was slightly in excess of 960 million gallons per day. Approximately 65 million gallons daily was used for public water supply purposes, 245 million gallons daily for private industry, 620 million gallons daily for electric power plants and 30 million gals. daily was diverted to the Delaware and Raritan Canal into the State of New Jersey for 12 customers. Of this total use of 960 million gallons daily, by 88 different groups, 827 million was taken from the river and 133 million from wells. This water use is summarized as follows:

Group	Number	River Average M.G.D.	Wells Average M.G.D.	Total Average M.G.D.
Public Supplies	23	27.44	37.47	64.91
Private Industries	50	150.04	95.11	245.15
Electric Power Plants	3	619.56	0.85	620.41
Customers supplied through Delaware and Raritan Canal	12	30.18	____	30.18
Grand Total	88	827.22	133.43	960.65

In the 14 counties in the Commonwealth of Pennsylvania on the Delaware River Watershed, the population served totals approximately 3,130,000 people and the total average water consumption is approximately 468 million gallons daily. These data are summarized in the following tabulation:

County	Number	Est. Pop. Served	Total Average M.G.D.
Wayne	3	10,000	1.180
Pike	2	1,125	.103
Monroe	7	18,050	3.420
Luzerne	2	51,600	5.700
Carbon	7	37,375	2.880
Northampton	7	166,800	14.500
Lehigh	3	104,575	23.422
Schuylkill	6	84,300	9.950
Bucks	4	29,025	6.200
Berks	10	142,900	5.732
Montgomery	4	81,360	10.550
Philadelphia	2	2,341,000	374.760
Chester	7	57,600	7.470
Delaware	2	12,750	2.100
Grand Total	66	3,138,460	467.967

This foregoing water use is for domestic purposes only. The Chamber of Commerce of Greater Philadelphia estimated that the five Pennsylvania counties in the Delaware Valley, U.S.A. draw approximately 2736 million gallons of water daily from the Delaware River for municipal and industrial use. This estimate includes private industries, public water supplies and electric power plants. This figure is comparable to the 827 million gallons daily take by the 88 groups in the State of New Jersey. It is obvious, when consideration is given to the present water usage of the Delaware River and the low flows which occur in the river during certain periods of the year, that the waters of this river pass through several industrial plants and likewise many intestinal tracts before it reaches the Atlantic Ocean. Estimates from a reliable source, and more conservative than those of the Chamber of Commerce, place the population of Delaware Valley, U.S.A , in the year 2000 at 6,400,000 persons; and the estimated domestic water consumption at approximately 1250 million gallons per day.

Citing one typical example of the use of the Delaware River for industrial purposes, it has been stated that the new U. S. Steel plant at Morrisville, Pennsylvania will use about 230 million gallons of water each day from the river. One source has recently estimated that the Pennsylvania industries along the Delaware and the Schuylkill Rivers use approximately 3500 million gallons of water each day, the larger portion of which was used for cooling water by the Philadelphia Electric Company at five steam generating stations.

Use of Delaware River in the State of Delaware

Because of the salinity intrusion in the Delaware Bay and River, the State of Delaware is interested chiefly in the estuary from the viewpoint of industrial water and seafood supply; although the tributaries of the river within the State are used for water supply purposes. This State has taken the stand that it is of vital importance to the continued growth and prosperity of Delaware

that the waters of the river shall be available in adequate quantities and suitable quality for the future water needs and requirements of the agricultural, industrial, minicipal and community demands.

As an example of the use of the waters of the river in this State, it has been said that the new Edge Moor Plant of the Delaware Power and Light Company will use approximately 345 million gallons daily of Delaware River water for cooling purposes.

Diversion of Water by New York City from the Upper Delaware River Basin

In 1929 the City of New York was proposing to divert from the Delaware River Watershed for water supply purposes 600 million gallons per day. This proposal was opposed by the State of New Jersey and it resulted in a case before the Supreme Court of the United States with the Commonwealth of Pennsylvania as intervenor. This case was referred to a Master and a great mass of evidence was taken. The Special Master found that the New York City diversion of 600 million gallons daily of Delaware River water was excessive and he cut the quantity which might be diverted to 440 million gallons daily. In his report the Special Master adopted the principle of "equitable division." He said that "The removal of water to a different watershed obviously must be allowed at times unless states are to be deprived of the most beneficial use on formal grounds." The Supreme Court of the United States handed down its decision in the Delaware River Case on May 25, 1931. As of today, the reservoirs intended to permit New York City to divert 440 million gallons of water per day, in accordance with the Decree, have not been completed. As a result, there has been no experience to enable an observation on the effect of the diversion.

On April 1, 1952 New York City filed a petition for the modification of the 1931 Decree of the Supreme Court. New York City now desires to increase its diversion of Delaware River water from 440 million gallons per day to 800 million gallons per day because its water use has increased materially. On last Monday, June 7, 1954, a Special Master's recommendation that New York City be permitted to divert up to 800 million gallons daily from the Delaware River and its tributaries was approved by the United States Supreme Court.

At a joint session of the Hydraulic-Sanitary Engineering Divisions to be held this afternoon, the problem involving New York's diversion will be discussed; and I will, therefore, refrain from commenting upon this matter.

The Philadelphia Water Supply Problem

Philadelphia is the largest community in the southeastern portion of Pennsylvania and it presently takes its water supply from the Delaware at Torresdale and out of the Schuylkill which is a tributary of the Delaware. The 1950 consumption average 359 million gallons daily.

During 1945 and 1946, Emerson, Jacobs, Requardt, Justin and myself, all members of the American Society of Civil Engineers, made an investigation and study and submitted a report on the future water supply for the City of Philadelphia. This Board of Consulting Engineers was charged with the task of: (1) To study the question of improving the present sources of supply of drinking water, and (2) To study the sources of water supply outside the City in the upland and mountain regions and to recommend the source which would best serve the City's needs.

This Board of Consultants recommended that the best source of water for

the City of Philadelphia is the upper Delaware River with a dam at Wallpack Bend near Bushkill, Pennsylvania. Numerous studies were made of alternate projects for an upland source of water supply which would be most desirable for Philadelphia. The sources investigated were:

1) The Delaware River-Yardley Project
2) The Upper Lehigh River Basin Project
3) The Upper Delaware River Tributary Project
4) The Upper Delaware River Project - Tocks Island
5) The Lehigh-Pocono Project
6) The Yardley-Wallpack Bend Project

It was determined that the volume of water required by the City of Philadelphia in the year of 2000, in view of its probable growth, could be fixed at approximately 500 million gallons per day. Please bear in mind that this investigation was made more than 8 years ago when Delaware Valley, U.S.A., was not conceived.

The recommended project, proposed the construction of an impounding dam on the Delaware River at Wallpack Bend with two alternate methods of conveying the water to the City of Philadelphia from this reservoir. The first, comprised the construction of a concrete-lined pressure tunnel, deep in ledge rock, which would deliver water by gravity to a regulating reservoir to be constructed near Warrington, Pennsylvania, with another tunnel delivering the water—also by gravity—to the Queen Lane Water Filtration Plant. The second, contemplated releasing water from the Wallpack Bend Reservoir to the Delaware River and then diverting this water at Yardley, Pennsylvania by constructing a low dam across the river and then conveying it by tunnel to the City of Philadelphia.

The Wallpack Bend Dam was to be 170 feet high and 1,850 feet long, constructed of concrete and it would create a reservoir with a storage capacity of 91 billion, 500 million gallons of water. This dam would retain flood waters in the winter and spring to make up for deficiencies in the dry summer. The lake formed by the dam at Wallpack Bend would be about one-half mile wide and 30 miles long, extending upstream to Port Jervis, New York. It was possible to install a power plant at the Wallpack Bend site with a capacity of 31,000 kilowatts. Approximately 151 million kilowatt hours of electric power could be available in the average year without interfering with the 500 million gallons daily water supply required by the City of Philadelphia.

During the early part of this investigation, the Lehigh Coal and Navigation Company, which owns extensive lands and water rights on the Upper Lehigh River, submitted to the Water Commission of Philadelphia a program to tap the Lehigh River and its tributaries for an upland water supply for Philadelphia. The Lehigh is a tributary of the Delaware. The Board of Consulting Engineers had already considered this same source but in fairness to the Company they made a thorough study of the Lehigh Proposal and the Board reached a decision that it would be unwise for the City to adopt the Lehigh as a source of water supply because:

1) The water yield was insufficient.
2) The plan prepared provided for insufficient releases to maintain a minimum flow of in the streams.
3) The water could not be used without filtration.
4) The conduits considered in the plan were inadequate.
5) The cost was underestimated.

It was, thus, the opinion of the Board of Consultants that the Lehigh River supply was not adequate to meet the future needs of Philadelphia and that the

Delaware River at Wallpack Bend was the source best suited to the requirements of that City.

The Levittown, Pennsylvania, Water Supply Problem

Much has been written regarding the construction of Levittown in the heart of Delaware Valley, U.S.A. 16,000 homes will be constructed in this community and the population is estimated at 60,000 persons. Initially, it was expected to obtain a water supply for Levittown from six 20-inch diameter wells with 4 additional wells to be drilled in the future. As construction progressed, tests indicated a decline in the capacity of the wells so that a yield of 4 million gallons daily was anticipated as the safe yield from these six wells. My firm was called into the picture 15 months after the start of construction of the housing project. A filter plant was recommended with a capacity of 8 million gallons daily to augment the well supply; the source of supply being the Delaware River. This is typical of the water supply problems involved in the communities along the river. Other municipalities on both the Pennsylvania and New Jersey side face similar situations because of the population and industrial growth which is occurring in Delaware Valley, U.S.A.

The Water Problem in the City of Chester, Pennsylvania

As far back as 1870 the City of Chester, located along the Delaware below Philadelphia, obtained its water supply from the river. Because of the high pollution load in the Delaware River at the waterworks intake of Chester, it was necessary for Chester to construct a new source of water supply. In addition, Chester was faced with a periodic problem of combating the intrusion of salinity from the lower bay. When the river flow was above normal, the salt content in the vicinity of Chester was low. In dry years, however, it was quite high.

Chester, in its wisdom, before the end of World War II had an engineering investigation and study made for a new water supply; and shortly after the war the construction of a dam, filter plant and pumping station was started along the Octoraro Creek in Pennsylvania and 40 miles of transmission main was constructed from the source. The total cost of this project was over $14,000,000. The population served is approximately 100,000 people. For several years Chester has now enjoyed the benefits of a new, modern, satisfactory source of water supply. This is a case where it was necessary for a municipality to abandon the Delaware as a source of water supply.

The Diversion of Water from the Delaware River to the Delaware-Raritan Canal by the State of New Jersey

In approving the Special Master's report, the United States Supreme Court, on June 7, 1954, gave New Jersey permission to divert 100 million gallons per day outside of the Delaware River Watershed through the Delaware-Raritan Canal without compensating releases. At the present, 12 industries are using about 30 million gallons daily from the Delaware-Raritan Canal. This water is diverted from the Delaware River.

The diversion of water without compensating releases, in accordance with the Supreme Court Decree, poses an additional problem upon the waters of the Delaware River; and such a diversion affects the volume of water available for the Delaware Valley, U.S.A.

The Minimum Flows in the Delaware River are Important

The records show that the rate of flow in the Delaware River throughout its entire length fluctuates greatly. At Trenton it has dropped as low as 800 million gallons a day (1250 cubic feet per second). Bearing in mind the figures which have been presented regarding the water use in the Delaware River, it will be obvious that the flow in the river is considerably less during low flow periods than the industrial and domestic use imposed upon the stream. On the other hand, the flow has been as high as 160,000 million gallons a day (250,000 cubic feet per second) or 200 times the minimum.

The problem is too much water now and too little water later.

It was concluded by Malcolm Pirnie and myself, in our Incodel studies, when the river flows drop below a rate of 3,000 million gallons per day (4800 cubic feet per second) at Trenton, that water captured, in reservoirs to have been constructed under that plan, during periods of high flow would be released from the reservoirs in sufficient quantities to maintain a rate of flow of at least 3,000 million gallons daily at Trenton. The flow at Trenton will be considerably less than this quantity under the Montague formulae approved by the Supreme Court.

Importance of Delaware River as a Source of Water Supply

The primary use of the Delaware River and its tributaries is for municipal and industrial water supply use. It is evident that the resources of the Delaware must be conserved to meet the future high water demands which are estimated for the Delaware Valley, U.S.A. If diversions from the watershed are to be made, then storage facilities to provide ample releases for low flow augmentation should be provided to compensate for this privilege. The advantages gained by the releases should outweigh or balance the concessions made. Both Pennsylvania and New Jersey in the Delaware Valley, U.S.A. must look to the Delaware as their sole available source of water supply for the future and it is high time that a comprehensive plan be adopted for the utilization of the waters of the river.

CONCLUSION

As I view the situation, it is imperative that a determination now be made as to how the waters of the Delaware River and its tributaries should be put to their best use in view of the present and future development in the Delaware Valley, U.S.A. This river is a "TREASURE" requiring wholehearted cooperation of its four proprietary states to conserve and develop its bounteous waters and to use these waters for the benefit of all. It is obvious that the needs of the people and the industries within the watershed of the Delaware River should come first and that the desires of those outside of the watershed should come second.

Benjamin Franklin said. . "When the well is dry, then we know the worth of water."

PROCEEDINGS-SEPARATES

The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Separate Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

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a. Presented at the New York (N.Y.) Convention of the Society in October, 1953.
c. Discussion of several papers, grouped by Divisions.
d. Presented at the Atlanta (Ga.) Convention of the Society in February, 1954.
e. Presented at the Atlantic City (N.J.) Convention in June, 1954.

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